PRESOAKING SEEDS INCREASES GERMINATION RATE AND SEEDLING DEVELOPMENT

Kenneth W. Outcalt[1/]

Abstract.--Even though Ocala sand pine (*Pinus clausa* var. *clausa* D. B. Ward) seeds are non-dormant, and thus do not require stratification, soaking seeds in water prior to sowing might increase the speed of germination. To test this hypothesis batches of seeds were soaked in water for 18, 24, or 48 hours at 4° or 22° C. These soaked seeds were sown, along with control seeds, in soil at 5 or 7 percent moisture content in germination boxes and then the boxes were placed on racks in a germination room with constant lighting. After 10 days the percent germination from soaked seeds was nearly double the value from control seeds. Soaking time did not effect germination rate, but soaking at room temperature increased the percent germination by nearly 50 percent compared to soaking at 4° C. After 17 days, difference in germination between control and presoaked seeds had disappeared. Because of their earlier emergence, however, the seedlings originating from the presoaked seeds had 25 percent greater total biomass than the control seedlings.

Additional keywords: direct seeding, seed priming, Ocala sand pine, *Pinus clausa*.

Seed predation is a serious problem in regeneration of Ocala sand pine (*P. clausa* var. *clausa*) stands by direct seeding. If seed germination could be accelerated it should increase regeneration success by reducing the exposure time of the seeds to predation. Although seeds are non-dormant and thus do not require stratification prior to sowing, once the seeds are sown there is some lag time before germination and emergence, while the necessary water is being imbibed. Previous work (Outcalt, 1987) has shown that soaking seeds in water prior to sowing accelerates the speed of germination. The purpose of this study was to determine if the length of time and the temperature of the presoaking treatment significantly affect germination speed of Ocala sand pine seeds.

Ocala sand pine is native to the sandhills area of central Florida. The largest concentration occurs on an area of rolling hills known as the Central highlands, which encompass the Ocala National Forest. This area has hot, humid summers, somewhat dry winters, and a long growing season of 312 days (Burns and Hebb, 1972). Precipitation is abundant (52 inches per year), but more than half falls from June to September. In addition because of the low moisture-holding capacity of the soils, drought condition can exist within 2 weeks of a heavy rainfall.

[1/] Soil Scientist, Southeastern Forest Experiment Station, Gainesville, FL 32611.

Sandhill soils are acid, infertile, and droughty marine deposits from the interglacial stages of the Pleistocene epoch. Because of sorting action during deposition, they are largely quartz sands ranging from a few feet to more than 20-feet deep. Organic matter content is low because the climate promotes rapid oxidation. Because of the low levels of organic matter and clay colloids, cation exchange capacities and moisture retention of these soils are low (Burns and Hebb, 1972).

Most natural stands of Ocala sand pine have originated from seed released by serotinous cones following wildfires. Although fire can effectively regenerate the stand, it is undesirable because most of the original timber is lost. Some disturbance is needed, however, to maintain the type; otherwise these stands would gradually be overtaken by the more tolerant scrub oaks (Cooper et al., 1959).

A number of systems for artificial regeneration of Ocala sand pine stands following timber harvest have been tried. Because of serotinous cones, the seed-tree and shelterwood systems are not suitable. Attempts have been made to get natural regeneration by using the heat from the sun to open cones in logging slash, but stocking was below acceptable levels (Price, 1973). Burning logging slash to release seeds has also been tried, but available cones and logging slash were unevenly distributed and fire destroyed the seeds. Site preparation by chopping or chopping and burning, when logging slash was very heavy followed by broadcast seeding has been used extensively, but not entirely satisfactorily. Many areas (especially during years with extended drought periods, which occur about 3 years out of 10) fail to regenerate adequately. In addition, during years with good rainfall, many areas are overstocked and require precommercial thinning to prevent stand stagnation. In an attempt to improve spacing, eliminate precommercial thinning, and reduce costs, a new system, using a Bracke scarifier-seeder, was put into use a couple of years ago. This system was very successful the first year, but since then many of the areas seeded with it have failed to regenerate adequately, as have the majority of the areas that were broadcast seeded.

The poor success ratio has been the result of seed predation aggravated by adverse weather conditions. Cooper et al. (1959) concluded that the loss of seed to rodents, birds, and ants was the single largest obstacle to the successful regeneration of Ocala sand pine by artificial seeding. The ants from three anthills per acre were enough to remove all the seed from a stand, but fortunately concentrations of ants were a localized and rather rare occurrence. Rodents and birds, however, are a more persistent problem. On test areas without rodent and bird control only 3 percent of the viable seed sown ever germinated, while germination on spots protected from birds and rodents was 90 percent greater than on unprotected spots. Similar results occurred when Ocala sand pine seeds were sown on sandhill sites in northwest Florida (Burns and McReynolds, 1975) where substantial numbers of the seeds were lost to small rodents, birds, and ants.

METHODS

A sample of the Ocala sand pine seed being used for regeneration during the 1986-87 season was obtained from the Ocala National Forest. All seeds were from cones collected on the forest and processed by Ashe Nursery, Mississippi. Germination tests showed seeds were 80 percent viable.

The study was done under greenhouse conditions with constant lighting at the Olustee Laboratory using a split-plot factorial design with two replications. Control seeds were planted in half of each 17 x 12 x 6 cm germination box and presoaked seeds in the other half. Prior to sowing these seed had been placed in tap water at 4° or 20° C for 18, 24, or 48 hours, or were stored at the same temperatures for the same time periods. Initiation of treatments was staggered so that all seed samples were ready to sow at the same time. At the end of the treatment period the water was drained from soaked seeds and they were air-dried on towels for 1 hour. This removed surface moisture so seeds would not stick together. A subsample of each seed group was weighed and then dried at 65°C to determine moisture content. The surface A and E horizons from a Paola sand (hyperthermic, uncoated Spodic Quartzipsamment) soil at moisture contents of 5 and 7 percent by weight was used as the growing media. These moisture levels were chosen to represent a minimally adequate (5 percent) and a moderate level. All seeds were planted by pressing them into the soil about one-fourth inch.

The number of seedlings emerging from the soil was counted in each box 10 and 17 days following sowing. After the count at day 17 all seedlings, including the root system, were removed from each box and placed in a drying oven at 65°C until dry. Germination data were analyzed by analysis of variance for each of the two dates. Total seedling dry weights from control and presoaked seeds were analyzed by the paired comparison method.

RESULTS AND DISCUSSION

All of the control, i.e., non-soaked seeds, had moisture contents by dry weight of 7 percent. Soaking the seeds increased the moisture level about threefold (Table 1). The increase in moisture content appeared to be a little faster at 20°C than at 4°C, but after 24 hours any effect from temperature had disappeared. The increase in moisture level was quite rapid, reaching a peak after 48 hours with additional soaking of up to 10 days resulting in no further increase in moisture content.

Table 1.--Effect of time and temperature of water soak on moisture content of Ocala Sand Pine seeds

Soaking Time	Moisture Content by Soaking Temperature		
	4°C	20°C	Mean
hours		-percent-	
18	15	22	18
24	23	24	23
48	26	27	26
Mean	21	24	

The length of time seeds were soaked had no significant effect on speed of germination. Germination, after 10 days, was 24, 25, and 17 percent for seeds presoaked for 18, 24, and 48 hours, respectively. Because all soaking times raised seeds to essentially the same presowing moisture level, the lack of a response due to soaking time was expected. It is advantageous that soaking time is not critical as this would make treatment of a large amount of seed on an operational-scale more difficult.

Ten days after sowing, germination was 13 and 20 percent for seeds in soil at 5 and 7 percent soil moisture, respectively. By day 17 this difference had increased, with 72 percent germination for seeds sown in soil at 7 percent moisture and 42 percent germination for those in soil at 5 percent soil moisture. Past studies (Outcalt, 1987) have also shown higher soil moisture levels to increase germination speed of both control and presoaked seeds.

Presoaking the Ocala sand pine seeds did significantly increase the overall speed of germination, approximately doubling germination after 10 days (Table 2). The temperature of the presoak also effected germination, with the seeds given the room temperature soak having a 50 percent greater germination than those soaked in refrigeration. There were no significant interactions between any factors. Thus, presoaking gave an equal increase in germination speed at both 5 and 7 percent soil moisture level. This is fortunate since 5 percent is the level that more commonly would be found in dry soil under actual field conditions.

Table 2.--Effect of temperature during presoaking on germination of Ocala sand pine seed.

Days after sowing	Seed treatment	Germination by Treatment Temperature		
		4°C	20°C	Mean
			-percent-	
10	Presoaked	17a[1/]	28b	22c
	Control	12a	11a	11d
17	Presoaked	50	64	57
	Control	49	59	54

[1/] Means within a row or a column, for this time period, not followed by the same letter are significantly different at the .05 level.

By day 17, all effects on germination due to presoaking had disappeared. However, because they germinated earlier, seedlings from presoaked seeds were significantly larger and had produced 25 percent more biomass than those from control seeds. This should be advantageous to survival since older and larger seedlings, because of more secondary stem thickening, are better able to withstand the high temperatures that occur at the soil surface during the spring drought period.

Rapid germination is desirable because it reduces the exposure time of seeds to predation. Since even non-dormant seeds must imbibe enough water to reach some critical moisture level before certain physiological processes necessary for germination can begin, "priming" Ocala sand pine seeds by soaking before sowing appears to be a promising method of accelerating germination. Although soaking time was not found to be critical, 24 hours is recommended because of convenience and the possibility that longer time periods could reduce seed viability from the low-oxygen levels of the non-aerated water (Barnett and McLemore, 1967). Soaking should be done at room temperature to obtain maximum effectiveness.

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